Joint ICTP-IAEA Workshop on Environmental Mapping:
Effective education and training for involving citizens in environmental monitoring

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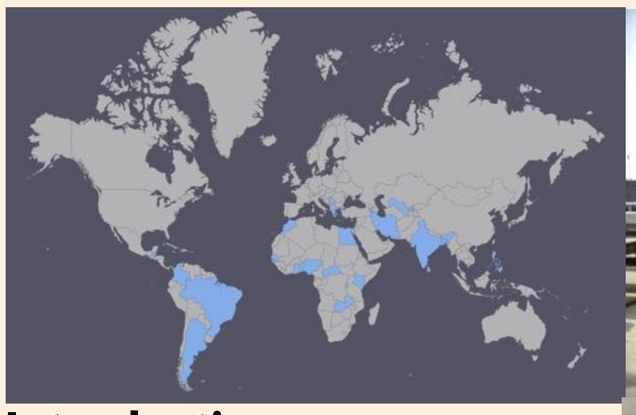


Introduction:

In March, 2017, a 3-week workshop entitled "Joint ICTP-IAEA Workshop on Environmental Mapping: Mobilising Trust in Measurements and Engaging Scientific Citizenry" (smr2858) was held at the Abdus Salam International Center for Theoretical Physics (ICTP) in Trieste. This workshop, jointly organized by staff from the ICTP, IAEA, and the NPO Safecast, brought together expert instructors from related fields to provide participants with both broad and in-depth knowledge and skills in citizen-science-based environmental monitoring. This workshop attempted both to train an international group of specialists in these new techniques, and to develop an educational methodology and curriculum that may be adapted, efined, and reused.

Upper left: Map showing participants' countries
Upper right: Particpants and instructors
Above right: Building bGeigie nanos. For many it was their first time building electronics.

The workshop had several primary areas of activity and learning:

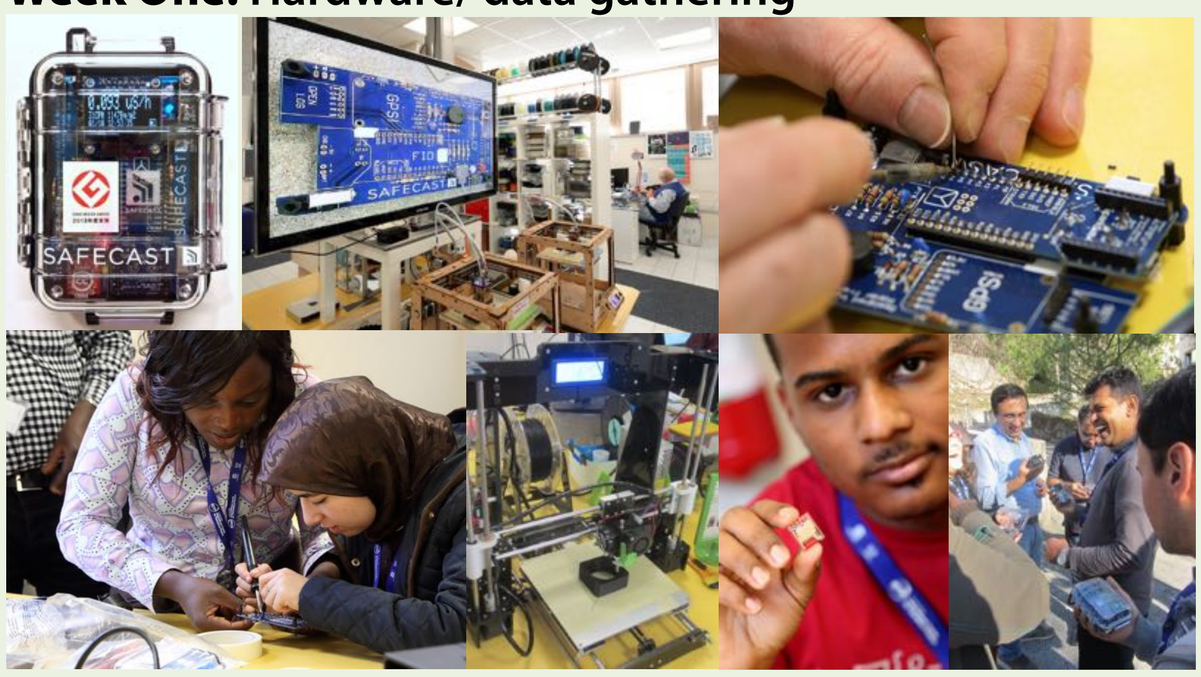
1) The construction of a Safecast bGeigie Nano radiation detector and exploration of other open-source hardware
2) An introduction to the use of low-cost 3D printing and scientific FabLabs.
3) Citizen science environmental mapping projects initiated by the participants over the course of the workshop.
4) Lectures and practical training in the use of open-source GIS software tools.

Participants: 29 people representing 25 nations:
Africa: Morocco, Nigeria, Benin, Kenya, Zambia, Rwanda, Ghana, Senegal,
Central/South America and the Caribbean: Cuba, Guatemala, Colombia, Dominican Republic, Argentina, Brazil,
Middle and Near East: Egypt, Iran, Uzbekistan,
Europe: Armenia, Greece, Serbia, Italy
Asia: Philippines, Bangladesh, Sri Lanka, India

Both graduate students and professionals were considered, and an effort was made to achieve an optimum mix of people working in industry, academia, and government. Also, a balance of technical specialties was sought, including radiation measurement, environmental monitoring, hardware design, remote sensing, GIS, data analysis, and others. Applicants were required to provide a statement describing their interest in citizen science and how participation in this workshop would benefit both their own professional development and development needs in their home countries. Priority was given to applicants from developing countries in Africa, Central/-South America and the Caribbean, and the Middle and Near East. A 50:50 male:female ratio was sought.

Staff: ***Directors/organizers:*** 3 (one each from IAEA, ICTP, and Safecast); ***Lecturers:*** 7; ***Speakers:*** 20

Week One: Hardware/ data gathering



Upper row: left: bGeigie Nano; Center: ICTP SciFabLab ; Right: Participants leaned to solder components
Lower row: Far left : Participants help each other build the bgeigie; Left: 3D printer in use; Right: Becoming familiar with electronic compnents; Far right: Joy at successful outdoor test of the bgeigies.

Week one multi-day hands-on lab: **bGeigie Nano assembly, programming, and operation**
90-minute lectures: **radiation detection and measurement; soldering technique and safety; Safecast project results; digital fabrication; open hardware; citizen-science based air-quality monitoring; citizen-science based air traffic and RF spectrum monitoring**

The primary activity during the first week was an intensive lab devoted to building the Safecast bGeigie Nano radiation detector. This open-source device is equipped with GPS and data-logging capability, and works seamlessly with the Safecast open radiation database and mapping system. It is comes as a kit to be self-assembled, which allows learning about hardware construction in general and radiation measurement systems in particular. In addition, building it provides the user with a sense of achievement and pride, meaning they are more likley to use the devce and and encourage others to do so as well. In addition to the bGeigie lab, lectures and instruction were given on open-source sensor systems, such as for air-quality monitoring, on digital fabrication, and other applications.

References:

The final program and course material can be found here: http://wireless.ictp.it/citizenscience_2017/

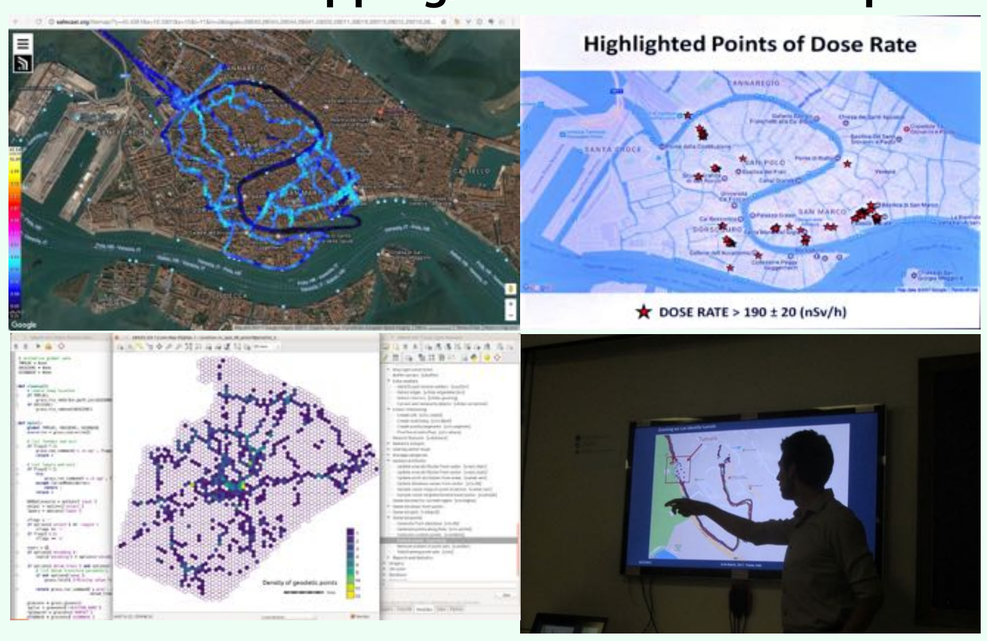
1) Safecast: successful citizen-science for radiation measurement and communication after Fukushima, A Brown *et al* 2016 *J. Radiol. Prot*. 36 S8
2) Low-cost 3D printing for science, education and sustainable development, E Canessa, C Fonda, M Zennaro *Low-Cost 3D Printing* 11
3) The DIY electronics transforming research, Cressey *Nature* 544, 125–126

Field activity:

On weekends particpants conducted self-directed data gathering in the field, using the bGeigie Nanos they had bult. This data was used as the basis for GIS visualization and analysis. This activity provided strong team bonding among the diverse international participants.

Left: Participant group conducting field data gathering in Venice.
Right: Data-gathering in Venice.

Week Two: Mapping/visualization and open-source tools



Top left: radiation data gathered by participants in Venice.
Top right : Team -based analysis of Venice data
Bottom left: QGIS open-source map-based data analysis and visualization software.
Bottom right: A participant presents his team's GIS analysis of Trieste radiation data.

Week two multi-day hands-on lab: **Internet-based GIS visualization tools**
90-minute lectures: **data visualization; big data; machine learning; open hardware design and fabrication; mobile data collection**
Presentations: **Team-based GIS analysis and visualization report; participants work in their home countries**

The primary activity during the second week was an intensive hands-on lab on using open-source QGIS software for data mapping and visualization. Participants were divided into teams, and each chose an appropriate data set to map and analyze. The team results were presented at the end of the week. In addition, particpants were introduced to other open-source data tools, including the Safecast web-based tilemap and API; big data tools and concepts; and other aspects of open-source hardware fabrication.

Week Three: Science communication

Left: Participants learned how to avoid common science communication pitfalls through practice interviews.
Right: Lecture on "Physics without Borders"

Week three half-day hands-on lab: **Using Google Tools for Science Communications**
90-minute lab: **Decision-making exercise**
90-minute lectures: **Risk Governance; Activities of Nuclear Transparency Watch; UN Sustainable Development Goals; Communicating science through the media; Physics Without Frontiers and the Atlas experiment; The Calflora Database; Stakeholder Engagement; Virtual archaeology.**
Summary activities: **Debate; Review; Closing; Awards and Certificate Presentations**

Week Three provided participants with a broad introduction to science communications issues. This included a half-day introduction to using Google News tools to strengthen media accountability and literacy. A former IAEA public relations officer provided useful advice for dealing with the media, and conducted practice media interviews. Practitioners also heard from experienced experts about ethics and transparency, risk communication, and stakeholder engagement, and conducted team-based exercises on priority determination and decision making. The week ended with summary discussions and reviews.

Results:

Samples of radiation data submitted to the Safecast dataset by participants:
Left: Accra, Ghana ;
Center: Abdijan, Cote d'Ivoire ;
Right: Lagos, Nigeria

All of the participants attended daily and successfully completed the course work, labs, and assignments. Success was also met in the broader goal of encouraging citizen science activity in environmental sensing in developing countries. This workshop seeded this activity widely, training professionals in the use of these tools and preparing them to inform others and initiate activity in their home countries. The immediate results have been very promising. Almost all of the participants began collecting and submitting background radiation data to the Safecast database upon their return home. For 19 of the 22 countries so represented this was the first Safecast data collected. During the workshop, communication was facilitated by the use of social media groups, and activity in these groups has continued to date. Many participants have presented the Safecast system and other citizen science information formally and informally to their home institutions and colleagues, and have reported tremendous interest. Interest has been expressed in utilizing the bGeigie system in educational contexts in some countries. In addition, directly as a result of this workshop, the national radiation laboratory of one African nation has expressed interest in conducting a nationwide radiation survey using the Safecast system. In all of these ways, the workshop has been successful in furthering the wider goals of introducing citizen science tools and methods to many areas of the world where it can fill essential needs. It has also resulted in the significant growth of the Safecast community in developing nations.